Chehalis River Basin Pilot Assessment

WRIA's 22 and 23
The Chehalis Basin

Overview

The Chehalis River basin (WRIAs 22 and 23) is the southernmost basin in the SSHIAP project area. Second in size only to the Columbia River, the Chehalis drains 2,660 square miles of Southwest Washington. From its headwaters in the Willapa Hills to its mouth at Grays Harbor on the Pacific Coast, some 1,391 rivers and streams encompassing 3,353 linear miles flow into the mainstem, including streamflow from both the Olympic and Cascade Mountains (Williams et al. 1975).

The Catalog of Washington Streams (Williams et al. 1975) divides the Chehalis basin into lower (WRIA 22) and upper basins (WRIA 23). Major drainages within the lower Chehalis basin include the Humptulips, Hoquiam and Wishkah Rivers which flow into Grays Harbor, and the Satsop and Wynoochee Rivers which enter the river proper along the uppermost extent of tidal influence. Major drainages within the upper Chehalis basin are the Black, Skookumchuck and Newaukum Rivers (LCCD 1992).

Evaluations of stock status by several independent sources indicate that most of the stocks within the Chehalis basin are healthy. The Salmon and Steelhead Stock Inventory (SASSI) identified 28 stocks within the Chehalis River system (Table 1, WDFW 1994). Of these 28 stocks, 75% are healthy, 11% are depressed, 14% are unknown, and none are critical. In contrast, 31% of the 434 stocks in Washington state are either critical or depressed. Similarly, an assessment of healthy stocks in the Pacific Northwest rated four of the chinook stocks, one chum stock, and three winter steelhead stocks in the Chehalis Basin are classified as healthy based upon an estimated adult abundance of up to two thirds that of historic levels (Huntington et al. 1994).

Hatcheries play a significant role in the propagation of Chehalis salmon and steelhead stocks. All seven coho stocks, 56% of chinook stocks, and 25% of steelhead stocks are of mixed origin, having originated from commingled native and non-native parents, or having undergone substantial genetic alteration (WDFW 1994). The location and production of hatchery facilities in the basin are listed in Table 2.

Geographic Description

The Chehalis basin is divided into two WRIAs. WRIA 23 encompasses the upper Chehalis River and its tributaries above and including Porter Creek, and WRIA 22 the lower Chehalis including the mainstem through to the mouth of Grays Harbor, and all tributaries to both river and harbor. The Chehalis is further divided into 47 Washington State Administrative Units or WAUs (Table 3).

The headwaters of the Chehalis are in WRIA 23, where the mainstem is formed by the union of the East and West forks flowing north out of the Willapa Hills. Near the town of Doty at RM 100, the Chehalis turns east through a broad valley and is joined by the South Fork Chehalis at RM 88.3 and the Newaukum River at RM 75.4. From the Newaukum, the Chehalis again turns north through the towns of Centralia and Chehalis and is joined in the town of Centralia by the Skookumchuck River at RM 67. The Black River enters near the town of Tumwater at RM 47. The junction of Porter Creek at RM 33 south of the Black Hills marks the lower of boundary of WRIA 23.

Downstream of Porter Creek in WRIA 22, the Chehalis valley widens and the river branches out into a complicated network of sloughs, backwa-

Table 1. Salmon and steelhead stocks utilizing the Chehalis basin (WDFW 1994).

Species	Stock	Status	Stock Origin	Production Type
Spring Chinook	Chehalis	Healthy	Native	Wild
Summer Chinook	Satsop	Depressed	Mixed	Wild
Fall Chinook	Humptulips	Healthy	Mixed	Wild
	Hoquiam	Healthy	Native	Wild
	Wishkah	Healthy	Native	Composite
	Wynoochee	Healthy	Native	Wild
	Satsop	Healthy	Mixed	Composite
	Chehalis	Healthy	Mixed	Wild
	Johns/Elk & South Bay	Unknown	Mixed	Wild
Fall Chum	Humptulips	Healthy	Native	Wild
	Chehalis	Healthy	Native	Wild
Coho	Humptulips	Healthy	Mixed	Composite
	Hoquiam	Healthy	Mixed	Composite
	Wishkah	Healthy	Mixed	Composite
	Wynoochee	Healthy	Mixed	Composite
	Satsop	Healthy	Mixed	Composite
	Chehalis	Healthy	Mixed	Composite
	Johns/Elk & South Bay	Healthy	Mixed	Composite
Winter Steelhead	Humptulips	Healthy	Native	Wild
	Hoquiam	Healthy	Native	Wild
	Wishkah	Healthy	Native	Wild
	Wynoochee	Healthy	Mixed	Composite
	Skookumchuck/Newaukum	Depressed	Mixed	Composite
	Satsop	Depressed	Native	Wild
	Chehalis	Healthy	Native	Wild
	South Harbor	Unknown	Native	Wild
Summer Steelhead	Humptulips	Unknown	Native	Wild
	Chehalis	Unknown	Unknown	Wild

Table 2. Fish culture facilities within the Chehalis basin (USFW 1993).

Location	Facility	Stock(s)
South Fork Newaukum	Merryman's Ponds	coho
North Fork Newaukum	Cole's Ponds	steelhead
Skookumchuck	Skookumchuck Pond	coho
	PP&L/WDFW ponds	steelhead
Satsop River	Mitchell Creek pond	cutthroat
	Muller Hatchery	coho
East Fork Satsop River	Simpson Hatchery	fall chinook, coho
	Satsop Springs	fall chinook, coho, chum
Van Winkle Creek	Aberdeen Hatchery	steelhead, cutthroat, coho & chinook
Wishkah River	Mayr Brothers Hatchery	fall chinook, winter steelhead
Humptulips River	Loomis Ponds	winter steelhead
	Humptulips Hatchery	fall chinook, coho, winter steelhead
Inner Grays Harbor	Hoquiam Netpens	coho
Outer Grays Harbor	Westport Netpens	coho
	Ocean Shores Netpens	coho

Table 3. Washington State Watershed Administrative Units (WAUs) Located in the Chehalis Basin, WRIAs 22 and 23.

Drainage	WAU Number	Name
Upper Chehalis	230112	Curtis
	230113	Chehalis South Fork
	230114	Stillman Creek
	230115	Chehalis Headwaters
	230116	Rock-Jones Creeks
	230117	Elk Creek
	230211	Scammon-Stearns Creeks
	230218	Bunker Creek
	230219	Lincoln Creek
	230220	Garrard Creek
	230307	Newaukum River, Upper North Fork
	230308	Newaukum River, Upper South Fork
	230309	Newaukum River, Upper Middle Fork
	230310	Newaukum River, Lower North Fork
	230403	Scatter Creek
	230404	Lower Skookumchuck River
	230405	Hanaford Creek
	230406	Upper Skookumchuck River
	230501	Waddel Creek
	230502	Black River
	230521	Cedar Creek
	230522	Porter Creek
Lower Chehalis	220105	Cloquallum Creek
	220106	Mox Chehalis
	220107	Delezene Creek
	220108	Elma
	220109	Satsop River
	220110	Montesano
	220202	West Fork Satsop River
	220203	Middle Fork Satsop River
	220301	Wynoochee River Upper
	220311	Wynoochee River South
	220416	Wishkah River
	220417	Raney Creek
	220418	East Fork Hoquiam River
	220419	West-Middle Fork Hoquiam River
	220423	Aberdeen Watershed
	220513	Ocean Shores Coastal
	220514	Humptulips River
	220518	Middle Fork Humptulips River
	220520	Stevens Creek
	220521	West Fork Humptulips River
	220522	East Fork Humptulips River
	220612	Johns River
	220625	Elk River

ters, and wetlands. The Satsop and Wynoochee Rivers, two of the largest subwater-sheds in the basin, enter at RM 20.2 and 13, respectively, while the Wishkah River marks the entrance of the Chehalis River into Gray Harbor. Both the Hoquiam and Humptulips Rivers flow into the north side of the harbor, while the Elk and Johns Rivers drain the Willapa hills to the south. Grays Harbor is approximately 15 miles long and 13 wide, and opens into the Pacific Ocean through a narrow channel north of Westport (Hiss and Knudsen 1993).

Geology

Much of the present character of the Chehalis headwaters developed during the Tertiary period (2 to 24 million years ago), when marine volcanic and sediment deposition was followed by sea withdrawal, uplift, folding and faulting. These processes formed the present-day Willapa hills, a region of steep and dissected V-shaped valleys and rounded hills ranging in elevation from 400 to 3,100 feet. Bedrock geology in the upper Chehalis is now characterized by highly erodible Tertiary sedimentary and volcanic rocks, which weather to silt, sand, and clay with some cobble and boulders (Sullivan 1994).

The lower Chehalis River valley is wider than would be expected from the channel course of the present day river, and was formed during a glacial dam break flood event at the end of the last Pleistocene ice age (Alt and Hyndman 1984). The floodplain is now characterized by glacial outburst flood, eolian, landslide, and coastal deposits (Schuster 1992). Quaternary alluvial deposits also characterize the lower Skookumchuck and Newaukum Rivers (R.W. Beck and Associates 1975). The surrounding hills, including the Black Hills in the Porter Creek watershed, are of Lower Tertiary volcanic rock. The steepest gradients are within the headwaters of the Humptulips, Satsop, and Wynoochee Rivers, all of which lie within the Lower Tertiary basalts of the Olympic range (Schuster 1992).

Climate

The climate of Southwest Washington is influenced by the Coast and Cascade Mountains, the surface temperature of the Pacific Ocean, the direction of prevailing winds, and the occurrence of oceanic high and low pressure systems (GHRPC 1994). Summers are cool with prevailing northwest winds and temperatures averaging 59 to 64^{0}F in July. Winters are wet and cool with frequent fog banks along the coast. Temperatures average between 38 and 40^{0}F in January. Except for the extreme upper elevations, most precipitation occurs as rainfall during the months of October through March. Rainfall averages 40 inches in the Chehalis Valley to more than 220 inches in the headwaters of the Wynoochee (LCCD 1992). There are no areas of permanent snowpack within the basin.

Hydrology

Most of the Chehalis basin lies within the rain zone, although snowmelt makes a limited contribution to streamflow in the Skookumchuck, Newaukum, Wynoochee and Satsop drainages. Flow regimes follow a pattern of groundwater recharge during the winter, and release during the summer. Peak flows typically occur between December and March, and low flows from July through September (Pickett 1992).

There are three permanent USGS gauging stations on the Chehalis River between RM 33.3 and 101.8, as well as stations on nine other tributaries (Table 4). Mean maximum flow on the mainstem ranges from 2,888 cfs at the Doty gauge to 19,050 at the Porter gauge (USGS 1994), with the highest flow on record being 58,500 cfs at Grand Mound in 1990 (ENSR 1994). Minimum flows range from 150 to 200 cfs at the Grand Mound gauge and 200 to 500 cfs at the Porter gauge, and are sustained by groundwater baseflow. During these periods, thermal stratification and anoxic conditions are prone to occur on the mainstem between Chehalis and Centralia, and in the Black River and other tributaries (Pickett 1992). Violations of oxygen and temperature standards may be of concern for both migrating adult and rearing juvenile salmonids.

Table 4. Average annual flow at selected USGS Gauging Stations within WRIAs 22 and 23.

	Gauge Location	Gauge Number	Drainage Area (sq. miles)	Average Annual Discharge (cfs)
WRIA 23 (Upper Chehalis)				
	Chehalis River near Doty (RM 101.8)	1202000	113	561[1]
	Chehalis River near Grand Mound (RM 59.9)	12027500	895	2756[2]
	Chehalis River at Porter (RM 33.3)	12031000	1, 294	6064[3]
	Newaukum River near Chehalis	12025000	155	488[4]
	Skookumchuck River near Bucoda	12026400	112	336[5]
	Cloquallum Creek		65	375[6]
WRIA 22 (Lower Chehalis)	Satsop River		299	1994[7]
	Wynoochee River above Black Creek near Montesano		155	1243[8]
	Wishkah River		100[6]	unavailable
	Hoquiam River		90[6]	unavailable
	Humptulips River		245	1344[6]
	Grays Harbor		----	11000[9]

1/USGS 1994; water years 1940-1994
2/ USGS 1994; water years 1929-1994
3/ USGS 1994; water years 1952-1994
4/ USGS 1994; water years 1929-1994
5/ USGS 1994; water years 1972-1994
6/data from Lewis County Conservation District 1994
7/ USGS 1994; water years 1929-1994
8/ USGS 1994; water years 1957-1994
9/ Mean daily inflow of which Chehalis River contributes 8,000 cfs. Data from Grays Harbor Estuary Management Plan, DEIS, 1981.

Land Use

The Chehalis basin was once a mixture of Douglas fir and hemlock in the uplands, Sitka spruce along the coast, and western red cedars in the lowlands. So lush was the vegetation that the area around Grays Harbor was described as being “walled in by one of the heaviest stands of timber in the Pacific Northwest…[and] was once unapproachable except by water” (Washington State Historical Society 1941).

The Chehalis and Quinault Indians fished and hunted within the Chehalis basin prior to European settlement in the 19th Century. Grays Harbor was discovered by Europeans in 1792, and permanent settlements established at Hoquiam and Aberdeen in the 1850’s and 1860’s, and at Chehalis, Centralia, and Pe Ell between the 1870 and 1890 (WPWS 1950). Logging and agriculture became the predominant land uses and over time, have had the most extensive impact upon fish habitat. As populations have increased, industrialization and urban encroachment have also contributed to habitat degradation through a wide range of activities, including mining, channel dredging, damming, and industrial and non-point pollution inputs.

The first settlers raised cattle, but crops such as cranberries, hops, and bulbs were later introduced (GHRPC 1994). As of 1991, agricultural land comprised 9.7% of the Chehalis basin, including dairy and livestock farms and small crop farms growing hay, vegetables and grains. Cultivation has had four major impacts on fish habitat: 1) loss of side channel, slough, and pond habitats due to diking, particularly on the Wynoochee, Satsop and Humptulips Rivers, and to a lesser extent in the Skookumchuck and

Newaukum watersheds, 2) channelizing to control stream meander and improve grazing, notable examples being Hanaford Creek in the Skookumchuck watershed, and Bloom's Ditch in the Black River drainage, 3) riparian removal, either intentionally by farmers or by livestock trampling, and 4) water quality degradation from improper animal waste management and pesticide or herbicide application. Water withdrawal for irrigation has also over-allocated surface water flows in some subbasins (Hiss and Knudsen 1993).

Logging began in the lower Chehalis in 1881, joining and then later surpassing agriculture as a major economic activity (WPWS 1950, Hiss and Knudsen 1993). As of 1991, approximately 77% of forests in the upper basin and 91% of forests in the lower basin were managed for timber production by corporations, with limited state and federal holdings. Of the state and federal land, Washington Department of Natural Resources manages Capitol State Forest in the Black Hills, while the U.S. Forest Service manages the headwaters of the Skookumchuck, Wynoochee, Satsop and Humptulips Rivers (LCCD 1992). Since the last century, basin-wide logging has impacted fish habitat through sedimentation from road erosion and slope failure, the application of forestry chemicals, and, prior to 1987, the harvest of streamside vegetation.

The result has been a net loss in habitat quantity and quality from improper culvert installation, increased sediment inputs, insufficient instream wood, and elevated stream temperatures. Industrial development has been limited primarily to lumber and pulp mills in the Chehalis/Centralia and Aberdeen/Hoquiam areas, although a coal mine and power plant on Hanaford Creek have substantially reduced available fish habitat in that watershed. Gravel bar mining operations are scattered throughout the basin, degrading both riparian and in-stream habitat. Dams on the Wynoochee and the Skookumchuck Rivers have blocked anadromous access to many miles of

Table 5. Population change from 1980 to 1990 within the Chehalis basin (table reproduced from USFW 1993 as derived from Washington Office of Financial Management 1991).

Category	1990 Population	% of Total	Change since 1980
Total	116970	100	1.1
Unincorporated	56488	48.3	4.7
Incorporated	60482	51.7	-2.1
Unincorporated[1]			
Lewis County	29027	51.4	8.2
Thurston County	24603	43.6	14.6
Grays Harbor County	25858	5	-0.1
Incoporated			
Aberdeen-Cosmopolis-Hoquiam	27615	45.7	-8.1
Centralia-Chehalis	18480	30.6	4.7
Montesano	3270	5.4	-10.7
Elma	2420	4	-11
Ocean Shores	2262	3.7	27.3
Westport	1935	3.2	-1
McCleary	1515	2.5	6.8
Tenino	1295	2.1	1.2
Pe Ell	580	1	-6
Oakville	580	1	8
Bucoda	530	0.9	2.1

spawning and rearing habitat for steelhead, coho and chinook.

As of 1991, only 3% of the Chehalis River basin was urbanized, but this figure is expected to increase as a result of proximity to Puget Sound and the Interstate 5 corridor, and a growing state population (LCCD 1992). Table 5 provides estimates of population growth for the past decade within incorporated and incorporated areas of the Chehalis basin. Major population centers are the cities of Centralia and Chehalis within the upper basin, and Aberdeen, Hoquiam and Cosmopolis along Grays Harbor. Several smaller towns and hamlets are spread throughout the basin. Water quality has been a concern in the Chehalis basin for many years and is at risk of becoming more so with further increases in population densities.

Subwatershed Description

Skookumchuck Watershed

The Skookumchuck River lies within WRIA 23 and has a total area of 181 square miles. Bounded by the Deschutes River to the north and the Newaukum River to the south, the Skookumchuck heads in the Mount Baker-Snoqualmie National Forest and flows westward to its confluence with the Chehalis River at the city of Centralia. The upper watershed is managed primarily for timber, and the lower watershed for agriculture and mining.

Geography

The Skookumchuck is approximately 43 miles long and is divided into upper and lower watersheds by the Skookumchuck Dam at RM 22. The forested upper watershed consists of 21 miles of mainstem, approximately 60 miles of tributaries, and the 35,000-acre-foot Skookumchuck Reservoir. Pheeney, Eleven and Twelve Creeks are the only tributaries above the reservoir with significant amounts of accessible anadromous habitat. The remainder typically have high gradients with impassable falls near their mouths. Below the dam, the lower watershed consists of 22.1 miles of low gradient mainstem and over 100 miles of tributaries. Hanaford Creek enters at RM 3.85 and is the largest subwatershed, draining an area of 58.4 square miles. The Hanaford watershed is also the site of both the Centralia Steam Plant and an extensive coal mining operation which affects lower Hanaford Creek and its tributaries. Other major drainages to the Skookumchuck are Coffee Creek at RM 1.8, Salmon Creek at RM 18.3, and Johnson Creek at RM 18.4 (Williams et al. 1975, LCCD 1992).

Geology

Bedrock formations in the upper watershed consist of approximately 85% volcanic rock, with the remainder comprised of sedimentary sandstone interbedded with shale and coal. Surficial geology is characterized primarily by Quaternary alluvium and landslide deposits, and alpine glacial outwash. The resulting landscape is one of steep stream adjacent slopes and bench topography with high-gradient tributaries largely inaccessible to anadromous fish. Landslides are a natural occurrence, although management-related slope failures have increased since 1960 in association with road construction over quaternary landslide deposits. The result has been sediment delivery not only to type 4 and 5 channels, but fish-bearing type 1 and 3 channels as well (Russell 1995).

The lower watershed is characterized by lower Tertiary sedimentary rock (Schuster 1992) formed during a period of oceanic inundation when Cascade sand and silt was deposited into a shallow sea. Along Hanaford Creek, deposits of sediment into freshwater formed thin beds of carbonaceous shale and coal, including the Skookumchuck formation of the later Eocene (ENSR 1994). Surficial geology is dominated by ice-recessional sand and gravel outwash from the Puget lobe of the cordilleran ice sheet. Outwash material surrounds the city of Centralia at the mouth of the Skookumchuck (ENSR 1994) and provides spawning habitat for chinook in the mainstem. Salmonid habitat within lower Skookumchuck tributaries is typified by Hanaford, Johnson and Salmon Creeks, all of which are relatively low-gradient streams with associated wetlands for rearing, but minimal gravel for spawning except in upper Hanaford (Finn 1967).

Surface Water

The Skookumchuck River has three permanent USGS gauging stations at RM 6.4, 20.7 and 28.8. Mean annual flow ranges from 192 cfs above the dam to 336 at the lowest of the three gauges near Bucoda (USGS 1994). Above the dam, about 40% of the upper watershed is in the rain-on-snow zone, but under current hydrologic conditions, increases in peak flows of less than 5% are expected in most areas (Sullivan and Sherwood 1995). Below the dam, flows are regulated under a mitigation agreement between the dam owner, Pacific Power and Light, and WDFW to ensure sufficient water for spring and fall chinook spawning. Pacific Power and Light must maintain minimum releases of 140 cfs between September through November, 95 cfs in April, and 50 cfs between May and September.

Water Rights

Agriculture, coal mining, and the generation of electricity account for most of the water use in the Skookumchuck watershed. Agricultural interests hold irrigation rights to 893 acres, although only 400 acres worth were actually used as of 1992 (LCCD 1992). Of the industrial users, the greatest allocation is to Pacific Power and Light, which owns the Skookumchuck Dam and the coal-fired Centralia Steam Plant in lower Hanaford Creek. Pacific Power and Light holds a permit for 80 cfs, which is guaranteed by the 35,000 acre-foot reservoir behind the dam. The water is used primarily for coal washing and human consumption, and is not returned to the stream system. Of the municipal users, the town of Bucoda is permitted to draw up to 11.1 cfs but does not yet use it. Meanwhile, the City of Centralia is considering the Skookumchuck River to be a possible future source of municipal and industrial water. Remaining rights amount to 87.1 cfs and could not be supplied by the river if exercised simultaneously (LCCD 1992).

Water Quality

Water quality on the lower Skookumchuck River generally meets Class A state water quality standards (Thurston County 1995). However, the U.S. Fish and Wildlife Service recorded mainstem temperatures of 16^0 C during the summer of 1982, exceeding the threshold temperature of 14^0 C for salmonid egg development (Hiss et al. 1982 as cited in Pickett 1992). DOE has also listed the Skookumchuck in the 1996 305(b) report for exceeding pH limits (DOE 1996).

Coal mining has made the Hanaford watershed a focus of considerable attention since the construction of the steam plant in the early 1970's. During the initial phases of the coal mine and power plant project, field investigations revealed elevated turbidity, low oxygen, and high temperatures (McCall 1971 as cited in Pickett 1992). After assessing fish habitat in the Skookumchuck, Finn (1973) concluded that while the coal mines have the potential to release highly acid or alkaline water, the releases were not of sufficient magnitude to affect fish. Nevertheless, siltation and leachate from old coal dumps and abandoned mine shafts are becoming a growing concern (LCCD 1992). Based upon prior studies, the Department of Ecology has recommended investigation of mining impacts on turbidity, temperature, dissolved solids, and toxicity in Hanaford Creek (Jennings 1995).

Ground Water

There is minimal ground water information for the Skookumchuck watershed. However, based upon work done in the Newaukum and nearby areas, water-bearing formations in the Skookumchuck would likely include Tertiary basalts, shale and sedimentary rock, Tertiary and Quaternary alluvial terrace deposits, later Quaternary fluvial deposits, and recent alluvial deposits (ENSR 1994), most of which are to found below the dam (Ebbert and Payne 1985, R.W. Beck and Associates 1975). Ground water flow within the Skookumchuck probably follows a pattern similar to the rest of the Chehalis basin with groundwater recharge during winter and release during summer (Pickett 1992).

Groundwater contamination is a concern throughout the Chehalis River basin where, as of 1992, 37 contaminated sites were identified in four counties. Areas in which water percolates rapidly, as in the glacial outwash of the Black and lower Skookumchuck Rivers, are particularly sensitive to groundwater contamination from septic tanks. Groundwater concerns will likely continue to escalate in the face of increasing population growth (LCCD 1992).

Land Use

Land use within the Skookumchuck watershed is 70% forestry, 20% agricultural, 5% residential, 3% surface mining, and 2% commercial (LCCD 1992).

In the lower watershed, coal mining has had one of the greatest impacts to fish habitat. Between 1878 and 1969, more than 9 million tons of coal were mined in the Hanaford Creek watershed, mostly from Packwood and North Hanaford Creeks. Mining operations may expose up to 900 acres at a time (Hiss et al. 1982), not only destroying stream channels, but significantly increasing surface erosion and sediment inputs to streams.

The upper watershed encompasses 39,000 acres, most of which are managed as part of the Weyerhaeuser Vail Tree Farm. High road densities coupled with steep, unstable slopes account for most of the management-related impacts to fish habitat. Since 1960, a combination of high road densities (5.4 miles per square mile) and slash left in stream channels have contributed to a precipitous increase in sediment delivery to streams. Most road-related failures have occurred in Drop, Bigwater, Eleven and Twelve Creeks, where 19,000 tons of sediment have been delivered between 1960 and 1993, mostly to Type 4 and 5 streams, although also to Type 1 and 3 waters in Drop and Eleven Creeks. (Russell 1995) An additional 854 tons of sediment per year, or 16 percent of the total background sediment yield, enters the stream system from surface road erosion (Laird 1995).

Riparian Vegetation

There are distinct differences in the extent and composition of riparian vegetation between the upper and lower Skookumchuck watersheds. Most of the land above the dam consists of privately-owned tree plantations. Management for timber production has resulted in riparian vegetation that is mostly deciduous and of young age. Subsequently, 80% of the larger streams have low to moderate near-term wood recruitment potential. In addition to the impacts of timber management, dam break floods and channel morphologies conducive to wood transport have combined to create a situation of low in-channel LWD (Sherwood and Light 1995).

Besides affecting pool formation, sediment movement, organic matter storage and energy dissipation (Bisson et al. 1987 as cited in Morgan and Hinojosa 1996), high percentages of LWD are also correlated with higher overwinter survival of juvenile salmonids (Murphy et al. 1984a & b as cited in Morgan and Hinojosa 1996).

Reductions in stand age and composition may also impact salmonids by reducing stream shade and temperature conditions. Of 38 miles of inventoried Type 1 through 4 streams, 68% fell below target shade levels for Type AA water temperature standards (less than 16.3^{0} C) (Sherwood and Light 1995).

Below the dam, the conversion of land to residences and farms, and the placement of riprap and construction of dikes to stabilize banks and reduce flooding have all had a significant negative effect on riparian vegetation. Although less specific information exists for the lower watershed than for the upper, a 1991 U.S. Fish and Wildlife survey identified 5.3 miles of logging related impact, including bank vegetation removal, reduced canopy, and blowdown. An additional 7.4 miles of riparian encroachment, and 33.3 miles of reduced canopy were identified as resulting from agricultural, urban, and road-related activities (Wampler et al. 1993). Reduced canopy in the Hanaford watershed often translates into bank degradation and water temperature extremes.

Habitat Assessment

Watershed Level Assessment

The following sections will quantify how the impacts discussed above have limited the amount and quality of habitat necessary to maintain healthy wild anadromous stocks.

Lost Habitat

The anadromous zone of the lower watershed (to RM 22) contains 29.7 miles of large tributary, 155.1 miles of small tributary, and 0.3 miles of side channel habitat, while the upper watershed contains 14.1 miles of large tributary, 23.8 miles of small tributary, and 35,000 acre feet of reservoir (Figure 1). Habitat permanently lost to salmonids was assessed by comparing a 30' 1916 USGS topographic map and Stream Catalog maps of stream channels surveyed prior to mining to current 7.5' USGS topographic maps and 1992 aerial photographs. Lost habitat includes 1.6 miles of North Hanaford Creek, and one mile of an unnamed tributary west of Packwood Creek. An additional two miles of channel (Stream Catalog numbers 23.00768, 23.00769, and 23.0770) are no longer visible on either 1992 aerial photographs or current topographic maps, but the level of detail on historic maps is insufficient to document exact channel length and location.

Mining and agriculture has greatly modified riparian habitats and wetlands within the Hanaford valley, and it is likely that this analysis underestimates losses of side channel and off-channel rearing habitat.

Hydromodifications and Culverts

Hydromodifications were identified from several sources, and quantified from maps and stream survey data. Ditching and channel realignment, mining activities, and pond construction were measured from USGS 7.5" topographic maps. Bank hardening was located and measured using stream survey data collected in 1991 as part of the U.S. Fish and Wildlife Service Chehalis River Basin Study (Hudson et al. 1993, Wampler et al. 1993). Culverts were located from both topographic maps, the Upper Skookumchuck watershed analysis, field reconnaissance, and Washington State Department of Fish and Wildlife's Hydraulic Project Approval files.

The majority of ditching and channel realignment activities were observed in Hanaford Creek, and to a lesser extent in Coffee, Salmon, and Johnson Creeks, and on the mainstem Skookumchuck. These activities affect approximately 36 miles of stream channel or 22% of available anadromous habitat within the lower watershed (Figure 2). Another 2.2 miles of bank hardening were identi-

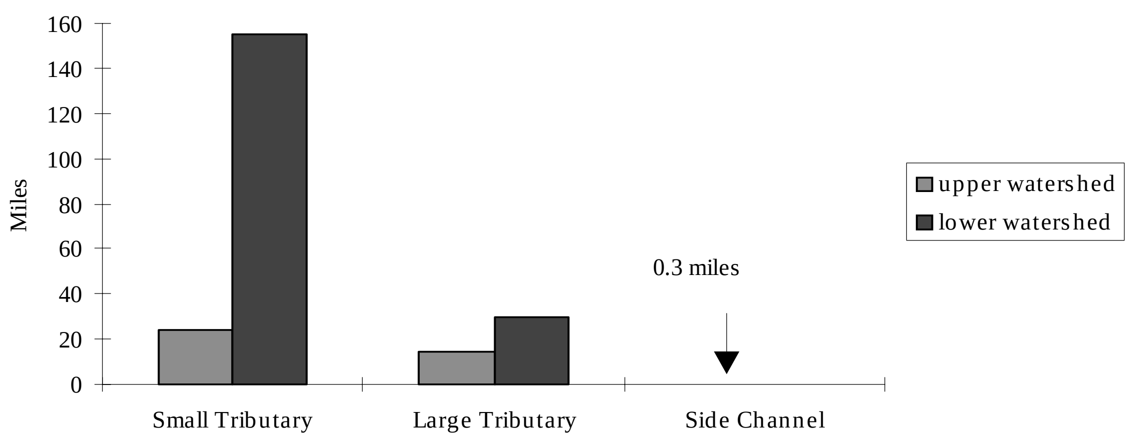

Figure 1. Total anadromous habitat in Skookumchuck River

fied in Hanaford Creek and along the mainstem Skookumchuck between river miles three and six. Mining and pond construction were limited exclusively to the lower Hanaford watershed and have affected approximately 8.25 miles of channel, or nearly 16% of available anadromous habitat. The construction of settlement ponds for mine tailings affected an additional 1.6 linear miles of channel. The ponds themselves amount to over 1,000 acres of surface area, as estimated from a DOE report of dams (DOE 1994). There is some question as to the accessibility and use of these ponds by fish. Nearly all appear to be associated with dams, and several appear in locations where active channels were once located (refer to Lost Habitat). Many of the ponds were constructed off-channel and at the least, represent a significant loss of coho rearing habitat.

Culvert location was divided into sediment source, transport, and response stream segments (per Montgomery and Buffington 1993). There are 308 culverts identified throughout the watershed (Figure 3). In the lower watershed, 60% of the culverts are in response reaches within the anadromous zone, indicating a potential fish passage problem. In the upper watershed, 55% of culverts are in response reaches and 25% in source reaches, suggesting a possible concern for both fish passage and fine sediment delivery.

Obstructed Habitat

Most of the anadromous habitat in the lower watershed is accessible, while Skookumchuck Dam bars access to all stocks but steelhead, which are hauled to the upper watershed and released. Below the dam, 3.5% or 4.5 miles of small tributary habitat are obstructed (Figure 4). Above the dam, 47.6 miles of large tributary and 157.8 miles of small tributary habitat are obstructed to all species but steelhead. Of that habitat, 6.4 miles or 21% of small tributary habitat are inaccessible to steelhead (Figure 5).

Dams account for most of the obstructed habitat although this analysis includes only Skookumchuck dam at RM 22 and two dams in the Hanaford Creek watershed identified by stream surveys as barriers (Wampler et al. 1993, Williams et al. 1975). There are at least 33 additional dams in the Hanaford watershed ranging in height from one foot to 285 feet and impounding a surface area of approximately 1047 acres. How-

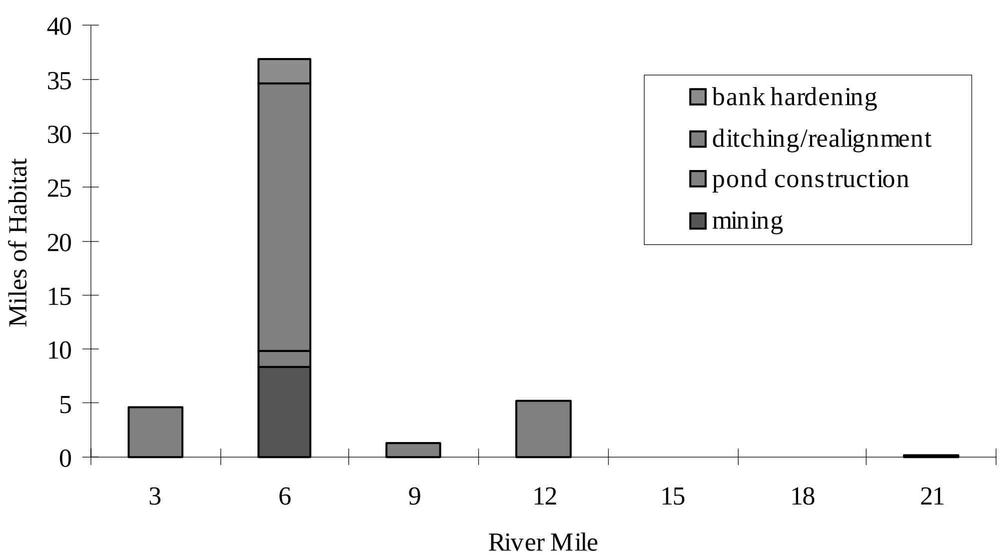

Figure 2. Miles of hydromodified anadromous fish habitat in the Skookumchuck River

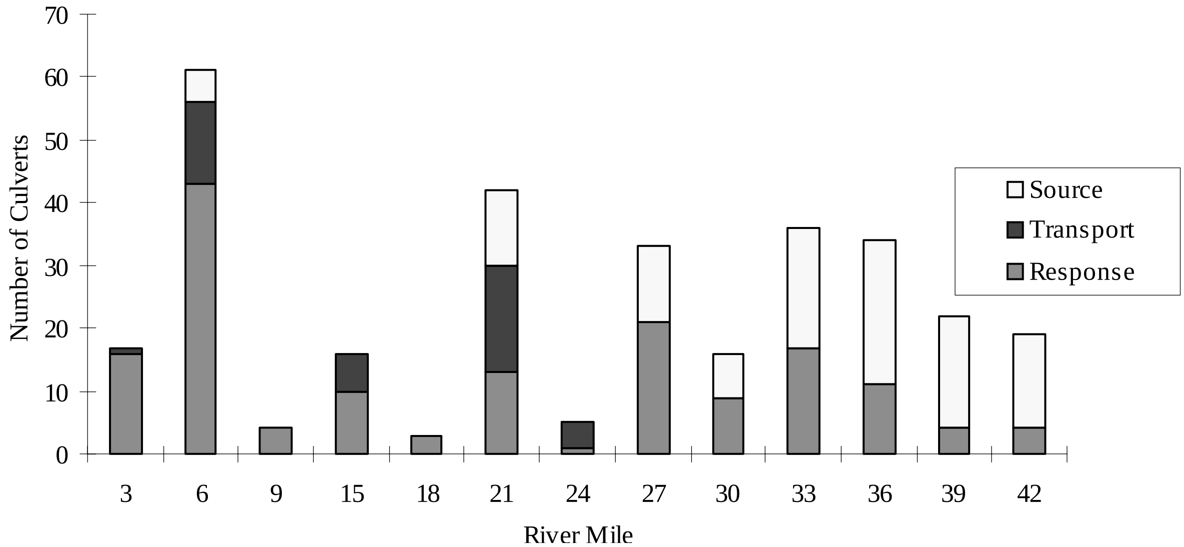

Figure 3. Locations and types of stream channel segments affected by culverts within the Skookumchuck River.

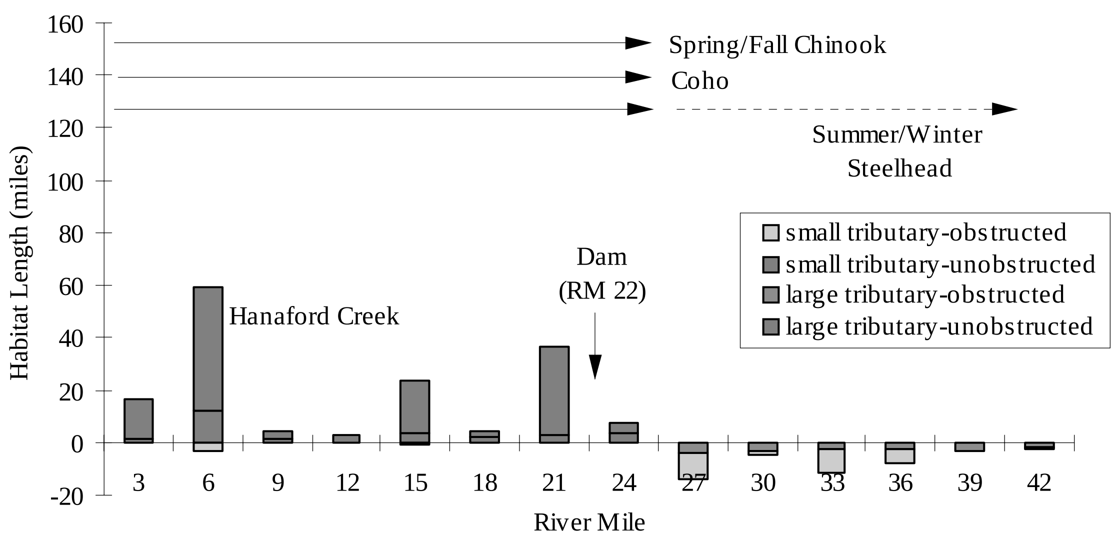

Figure 4. Lengths and types of available anadromous fish habitat in the Skookumchuck River.

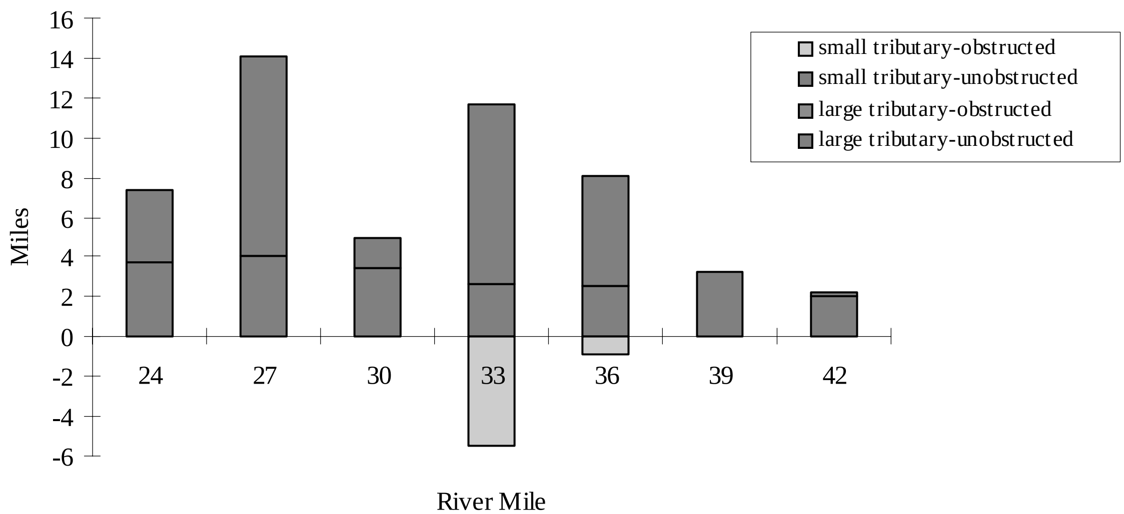

Figure 5. Miles of available steelhead habitat located above the Skookumchuck dam.

ever, given the extent to which surface flow has been altered, the impact of these remaining dams on fish passage is difficult to assess. Thirty-one are owned by Pacific Power and Light dams are for mine tailings except for one intended for flood control and water quality purposes. Most of the dams are described as off-channel, and appear on maps in areas that were likely to have been once been wetlands or small tributaries. Although only two instances of actual habitat loss could be documented, dams and strip mines have together contributed to much greater losses.

Culverts are another concern for fish passage in both upper and lower watersheds. There is a total of 308 culverts, 160 (51%) above and 148 below the dam. Twenty-one (13%) of those above the dam have been identified as barriers (Light 1995) through watershed analysis, obstructing a total of 6.5 miles of small tributary habitat. Aside from the USFW surveys (Wampler et. al 1993), no similar effort to identify culverts has been made in the lower watershed, where only one has been identified as obstructing 1.8 miles of small tributary habitat.

Stock Assessment

Chehalis Spring Chinook
Status: Healthy
Trend: Met escapement in 1986 for the first time since the early 1970's, but on the downswing through 1991. No data available for 1992 to present.
Timing: Enter January and February, spawn from early September to mid October.
Past and Present Distribution: Formerly spawned within the mainstem to RM 25.5 (near the confluence of Baumgard Creek at the tailout of the reservoir), with greatest concentrations in the canyon beneath the reservoir, and between the mouth and RM 12. Now spawn to the dam at RM 22 with heaviest concentrations from RM 19 to 22 between Thompson Creek and the dam (Figure 6). WDFW surveys suggest minimal use of tributaries for either spawning or rearing. Total available habitat: 107.4 miles (Figure 7).
Lost Habitat: Approximately 1.64 miles of the North Fork Hanaford Creek and one mile of an unnamed Hanaford tributary, both within strip mines.
Obstructed Habitat: Skookumchuck Dam obstructs passage to 3.0 miles of mainstem habitat. Channel destruction from strip mining

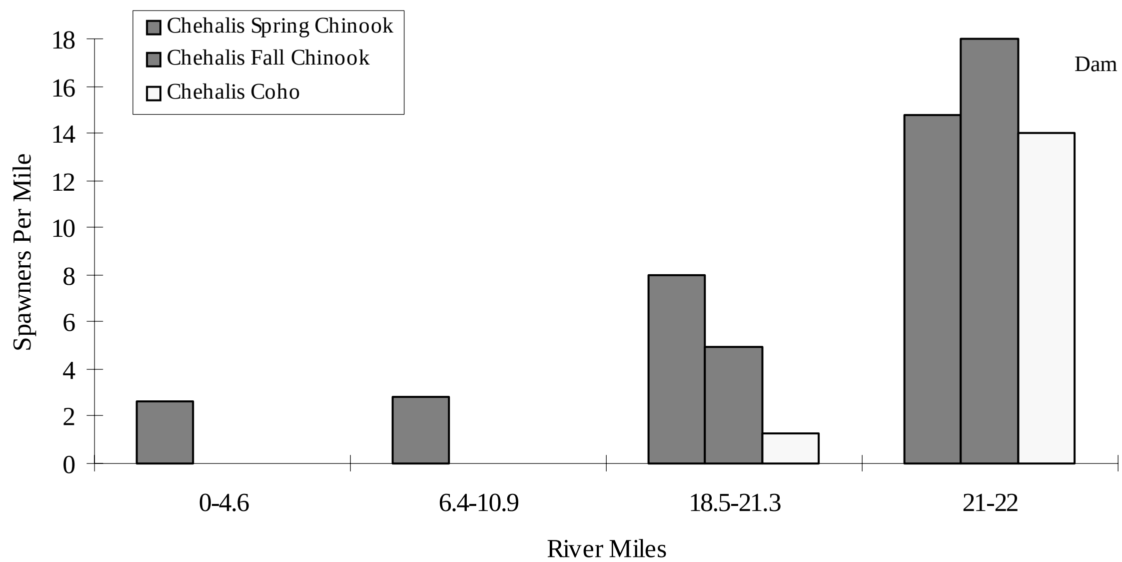

Figure 6. Spawning distribution of Coho and Chinook below Skookumchuck dam (data from WDFW).

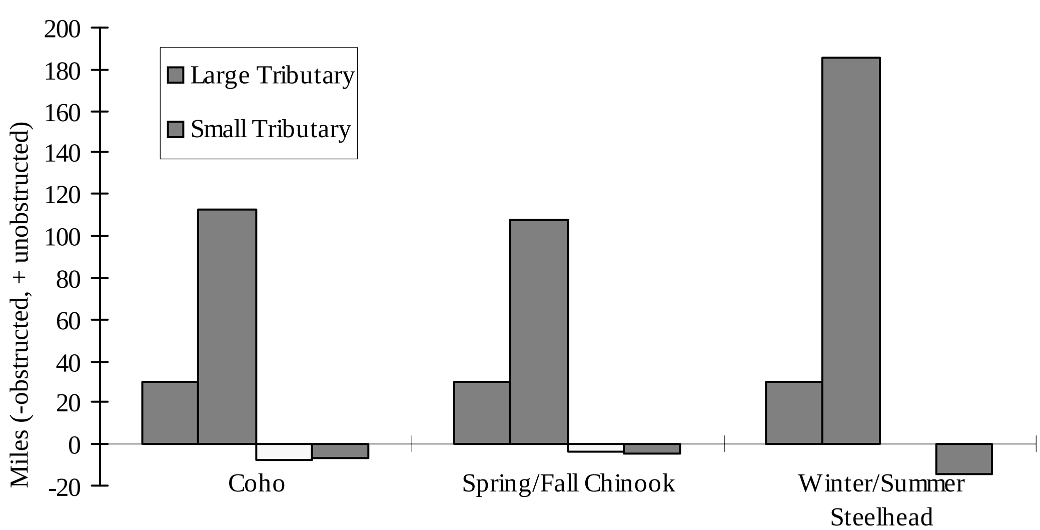

Figure 7. Total miles of available habitat for Coho, Chinook, and Steelhead stocks.

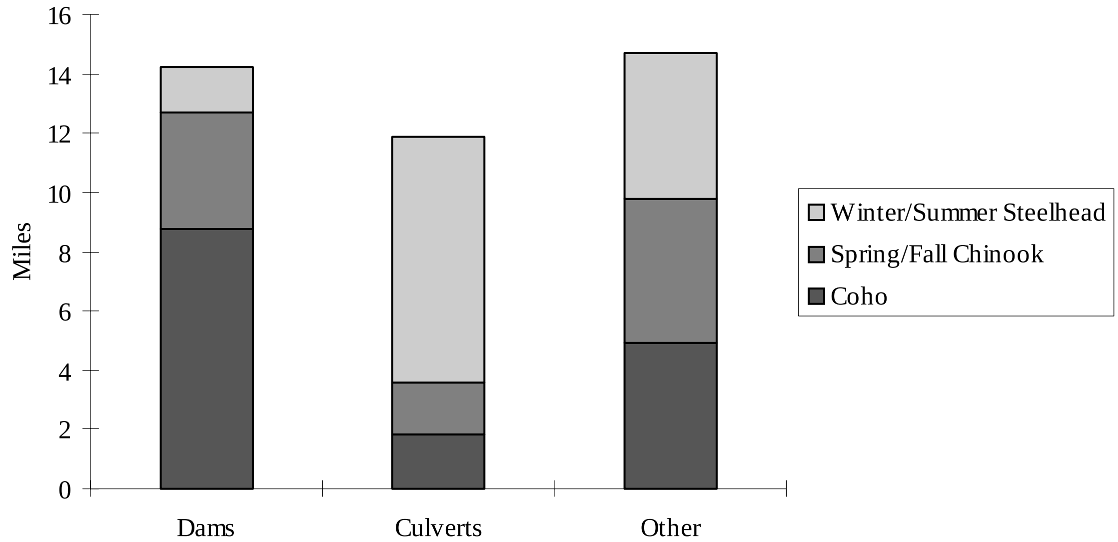

Figure 8. Miles of obstructed anadromous fish habitat located above barriers.

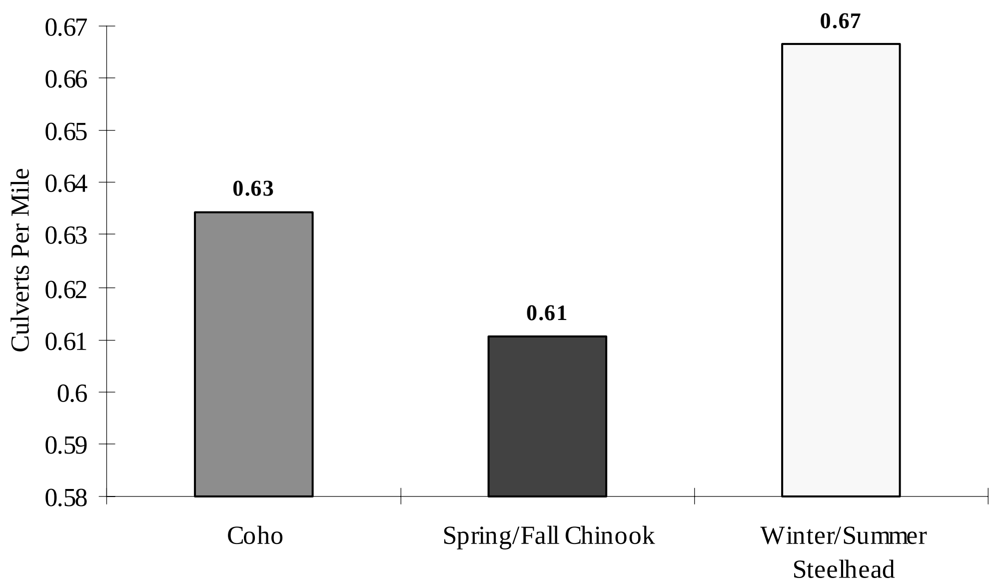

Figure 9. Culvert densities within anadromous fish habitat.

blocks an additional 2.9 miles of potential habitat on the North Fork of Hanaford Creek, and two Pacific Power and Light settlement pond dams another 1.25 miles (Figure 8).
Hydromodifications: Culvert densities within chinook habitat are approximately .61 per mile (Figure 9). Hydromodifications within habitat range are channel straightening (36 miles), mining (8.25 miles), bank hardening (2.2 miles), and pond construction (1.6 miles).

Chehalis Fall Chinook
Status: Healthy.
Trend: Met escapement in 1986 for the first time since the early 1970's, on the upswing through 1991. No data available for 1992 to present.
Timing: Enter early September through Octo-

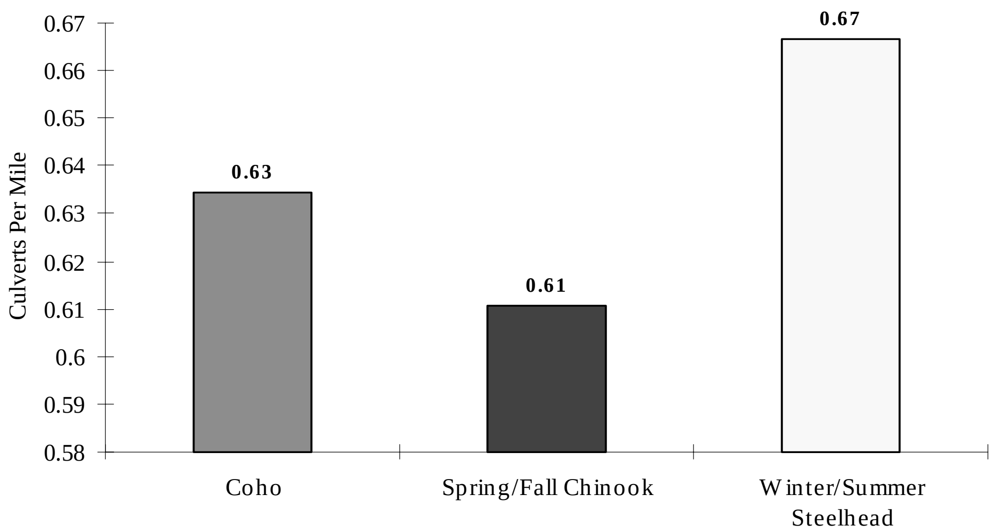

Figure 7. Culvert densities within coho, spring.fall Chinook, and steelhead habitats.

ber. Spawn from October through late November, peaking in late October, early November.
Past and Present Distribution: Same as for spring chinook. Now spawn to the dam at RM 22 with heaviest concentrations from RM 19 to 22 (Thompson Creek to the dam) (Figure 6). Limited use of tributaries. Total available habitat: 107.4 miles (Figure 7).
Lost Habitat: Same as for spring chinook.
Obstructed Habitat: Same as for spring chinook.
Hydromodifications: Same as for spring chinook.

Chehalis Coho
Status: Healthy.
Trend: Sharp downswing in escapement in 1985, followed by increases from 1987-1991. No data available for 1991 to present.
Timing: Enter October, spawn from November through January and February, peaking in late November, early December.
Past and Present Distribution: Formerly utilized the mainstem to RM 28.9 below Hospital Creek as well as lower Pheeny and Fall Creeks. Now limited to the watershed below the dam (Figure 6). Few natural barriers except beaver dams on Thompson Creek, and a falls on Bloody Run Creek. Most spawning occurs in tributary streams with concentrations in upper Hanaford Creek (Finn 1967). Limited spawning in Johnson Creek and lower Hanaford. Coho fry documented in Packwood and Coal Creeks in the Hanaford drainage, and in Johnson and Thompson Creeks (Finn 1973).
Total available habitat: 112.8 miles (Figure 7).
Lost Habitat: Approximately 1.64 miles of the North Fork Hanaford Creek and one mile of an unnamed Hanaford tributary from strip mining.
Obstructed Habitat: Skookumchuck Dam bars passage to 8.8 miles of mainstem and small tributary habitat (Figure 8). Coal mining obstructs 2.9 miles on North Fork Hanaford, and two Pacific Power and Light settlement pond dams another 1.25 miles on unnamed tributary 23.0744.
Hydromodifications: Culvert densities within coho habitats are approximately .63 per mile, mostly in response and transport reaches (Figure 9). Hydromodifications within habitat range include channel straightening (36 miles), mining (8.25 miles), bank hardening (2.2 miles), and pond construction (1.6 miles).

Newaukum/Skookumchuck Winter Steelhead
Status: Depressed.
Trend: Total escapement at the WDFW trap has declined to chronically low levels since the mid-1970's. In this mixed stock, wild fish have made

A channelized section of Hanaford Creek.

up an ever dwindling proportion of the total run since the installment of Skookumchuck dam in October 1970.

Timing: Run timing December through May, spawn timing mid-February to early June.

Historical Distribution: The only stock hauled above the dam, steelhead range up to the falls at RM 38. Natural barrier below the dam is a falls on Bloody Run Creek. Falls near the mouths of Pheeny, Laramie, Hospital, Eleven and Twelve Creeks and smaller tributaries block passage. Twelve and Eleven Creeks are more commonly utilized.

Total available habitat: 185.4 miles (Figure 7).

Lost Habitat: Approximately 1.64 miles of the North Fork Hanaford Creek and one mile of an unnamed Hanaford tributary from strip mining.

Obstructed Habitat: Below the dam, coal mining obstructs 4.9 miles of North Fork Hanaford Creek, and two Pacific Power and Light settlement pond dams another 1.6 miles on unnamed tributary 23.0744 (Figure 8). Twenty-two culverts bar passage to an additional 8.3 miles, all but one of these are above the dam.

Hydromodifications: Culverts are a concern above the dam where densities are .67 per mile (Figure 9). Location of culverts in sediment source reaches suggest the potential for erosion problems. Hydromodifications within habitat range include channel straightening (36 miles), mining (8.25 miles), bank hardening (2.2 miles), and pond construction (1.6 miles).

Chehalis Summer Steelhead

Timing: Run timing May through October, spawn timing unknown but believed to be from February through April.

Historical Distribution: Specific spawning locations unknown

Lost Habitat: same as for winter steelhead

Obstructed Habitat: same as for winter steelhead

Hydromodifications: same as for winter steelhead

Discussion

Major habitat issues within the Skookumchuck River watershed are:

1. Loss of spawning habitat for chinook and coho above the dam
2. Habitat loss and degradation from mining in the Hanaford subwatershed affecting coho rearing and spawning.
3. Channelization and damming effects on rearing habitat for all stocks in the lower watershed.
4. Maintenance of adequate temperature and flows for chinook spawning below the dam.

The only stock of concern in the watershed is Newaukum/Skookumchuck winter steelhead, which is depressed (WDFW 1994). Chehalis summer steelhead face many of the same habitat issues which have affected winter steelhead, but are a small run and as yet of unknown status. Although Chehalis spring and fall chinook have been characterized as healthy, these stocks did not meet escapement goals between the early 1970's and 1986. Both spring chinook and coho are both more likely to be impacted by the management of the dam than other stocks (Finn 1973) because of their dependence on adequate late summer flows and low temperatures.

Loss of spawning habitat for chinook and coho above the dam— Since the 1900's, three splash dams simultaneously blocked from 50 to 95% of migrating fish: (Rademacher and Raymond 1951, Wendler and Deschamps 1955): Agnew Dam at mainstem RM 3.7, Bucoda dam at RM 11.5, survey dam at RM 23.8 and a five-foot dam on lower Johnson Creek (Royal 1931, West 1931, Finn 1973). The last dam was removed in 1969. Since its completion in October 1971, Skookumchuck dam has blocked critical spawning habitat for spring chinook and coho, affecting an estimated 50% of spawning habitat in the system (Finn 1973).

The dam has had the greatest impact on chinook, which concentrated spawning in the canyon now inundated by the reservoir. Coho rearing in lower gradient tributaries above the canyon was also lost to the dam (Herger 1995), concentrating the majority of rearing habitat within the Hanaford Creek watershed. Pacific Power and Light has agreed to trap and haul steelhead above the dam, and to provide rearing for both coho and steelhead at Skookumchuck Ponds near the base of the dam.

This is of no benefit to the native Chehalis coho stock, however, since the fish are brought from outside of the watershed and released into Puget Sound (WDF 1991). No data are available on steelhead mortality from hauling.

Habitat loss and degradation in the Hanaford watershed—
Coal mining and agriculture have removed or degraded miles of potential coho rearing and spawning habitat. Between 1878 and 1969, more than 9 million tons of coal were mined in the Hanaford Creek watershed, mostly from Packwood and North Hanaford subwatersheds (Hiss et al. 1982). The result has been the elimination of several stream channels and a reduction in water quality, including elevated temperature, pH, and the presence toxic compounds (Pickett 1992). Besides eliminating channel habitat, the construction of settlement ponds and ditching to drain agricultural fields have simultaneously destroyed off-channel habitats and reduced or eliminated riparian function. Historically, the uppermost five miles of Hanaford Creek had the "best coho rearing and spawning habitat in the Chehalis basin" while below, the channel was dredged in "practically a straight line" for ten miles, creating a clay and mud bottom unsuitable for spawning.

Today, habitat function in lower Hanaford has been so degraded that the channel now serves only as a conduit for fish moving through to the upper watershed. It may also be of little surprise that chum were once observed in large numbers in Hanaford Creek in the 1940's but no longer utilize the Skookumchuck watershed (Royal 1931).

Channelization and dams in the lower Skookumchuck—
Below the dam, ditching and bank impoundments have reduced spawning and rearing capacity. Bed and bank degradation goes back to the splash damming era, when sudden releases of water and logs scoured the channel to bedrock, eroded banks and straightened the channels, obliterated pools, and destroyed spawning areas on the mainstem (Wendler and Deschamps 1955, Hiss and Knudsen 1993, GHRPC 1994).

The result was the creation of a plane-bed channel with few pools and minimal hiding cover. Today, ditching to drain agricultural fields coupled with the placement of rock for bank stabilization has comprised the riparian vegetation and subsequently reduced wood recruitment and shade cover throughout the lower watershed. Modification of natural channel meander has also eliminated side channel habitats and modified channel transport capability for wood and sediment.

Maintenance of adequate temperature and flows for chinook spawning below the dam— Temperature excursions critical to egg and alevin development continue to be a concern on the mainstem. Even when below critical levels, elevated temperatures stress spawning fish, making them more susceptible to disease and reduced fecundity (Cuenco and McCullough, 1996). For a stock prone to chronic low escapement, the cumulative effects of temperature and reduced spawning habitat can further depress local populations. The loss of prime spawning area above the reservoir requires further attention to the maintenance of suitable spawning conditions in the lower channel.

Restoration and Protection Strategies

1. Construct a fish ladder for Skookumchuck Dam. The construction of a fish ladder would gain an additional 7.5 miles of large and small tributary rearing and spawning habitat for coho and eliminate the need to haul steelhead.

2. Further existing efforts to improve degraded habitat in Hanaford Creek. Hanaford represents the largest drainage in the Skookumchuck, and one of considerable historical importance to coho. Current restoration efforts include the Lewis County Conservation District and Chehalis Rivers Council's "Shade the Chehalis" program to fence out cattle, stabilize banks, and revegetate riparian areas. However, a more ambitious approach would be to return strip mined habitat to anadromous production. In the past, Pacific Power and Light announced plans to restore strip mined areas through revegetation and the construction of recreational ponds. This idea should be revisited.

3. Continue habitat restoration efforts in the lower Skookumchuck watershed. Provide support for both Lewis County Conservation District and the Chehalis River Council.

4. Identify and correct sources of poor water quality in Hanaford Creek. Long term trend monitoring is needed to establish the nature and extent of water quality problems in Hanaford Creek.

5. Survey and modify blocking culverts in the lower watershed.

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